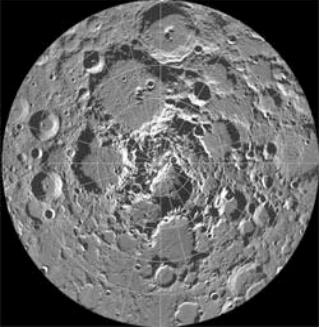
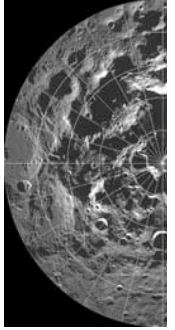
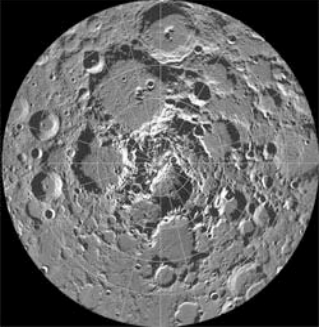




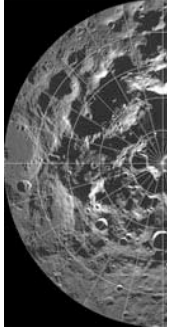
Lunar Compositional Information Provided by Orbital Neutron Data from the Lunar Reconnaissance Orbiter (LRO)

David J. Lawrence[1], D. Ben Bussey[1], Joshua T. Cahill[1], Vincent R. Eke[2], Richard C. Elphic[3], William C. Feldman[4], Herbert O. Funsten[5], Thomas H. Prettyman[4], and Luis F. A. Teodoro[6]

[1]Johns Hopkins University Applied Physics Laboratory
[2]University of Durham
[3]NASA Ames Research Center
[4]Planetary Science Institute
[5]Los Alamos National Laboratory
[6]Eloret Corporation; NASA Ames Research Center

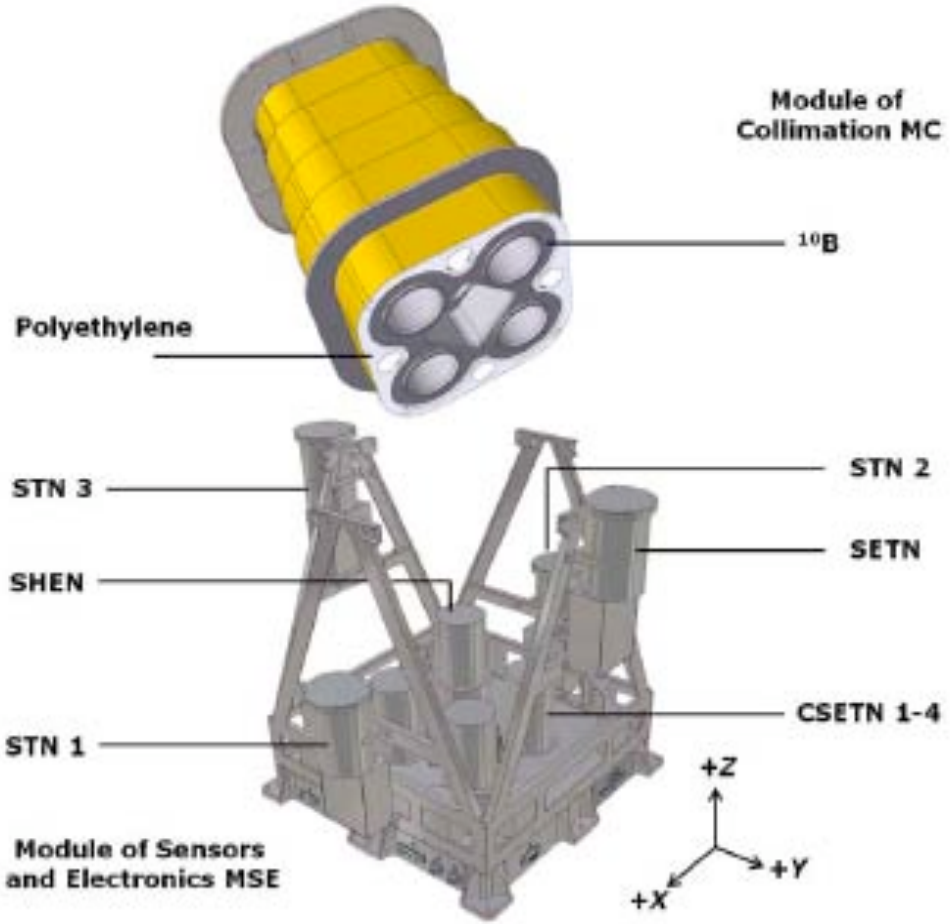


Goal of Study

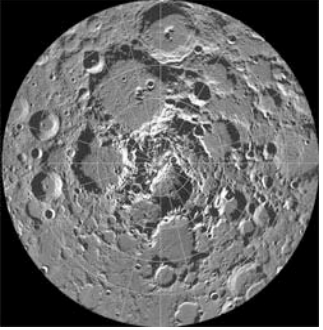


- The APL LSI node has a task to study surface-based hydrogen measurements using neutrons
  - Medium energy (or epithermal neutrons) strongly sensitive to planetary hydrogen abundances.
  - LSI study includes use of uncollimated/collimated neutron sensors.
- ***Goal of study:*** Use LRO neutron data to provide a benchmark understanding for uncollimated/collimated neutron sensors. ***Current presentation restricted to epithermal neutrons.***
- The LRO Lunar Exploration Neutron Detector (LEND) is an orbital, collimated neutron detector.
  - Use PDS data from 9/15/2009 to 3/15/2010.
  - Use additional information from the LEND team.

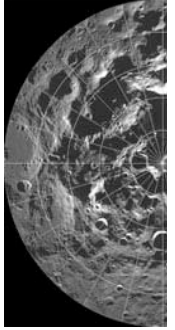
LEND Sensor Overview

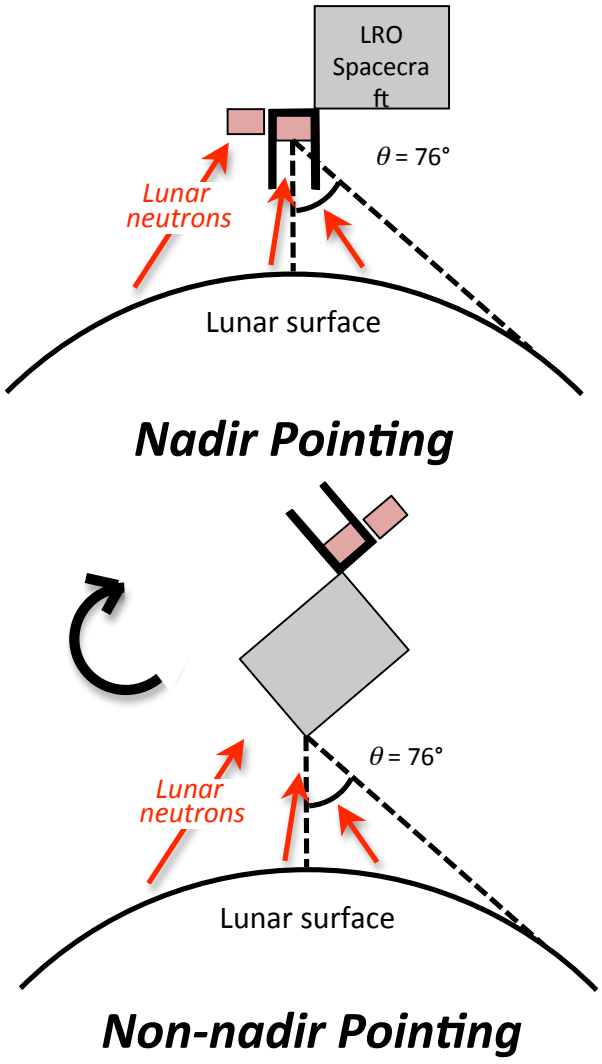


- STN1, STN2, and STN3 are uncollimated thermal neutr sensors.
- SETN is an uncollimated epithermal neutron sensor
- CSETN1 – 4 are four collima epithermal neutron sensors

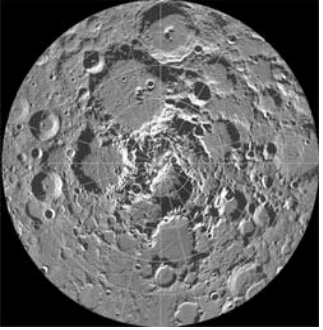


Spacecraft Rotation





- The LRO spacecraft has separate periods of nadir and non-nadir pointing.
  - Instrument design optimized for nadir pointing.
  - Data useful for understanding sensor angular response.
- For non-nadir pointing, the spacecraft and collimator block neutrons from hitting the sensors.
- From 9/15/2009 to 3/15/2010, there were six periods when the nadir angle was greater than 100°.



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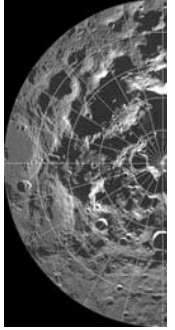
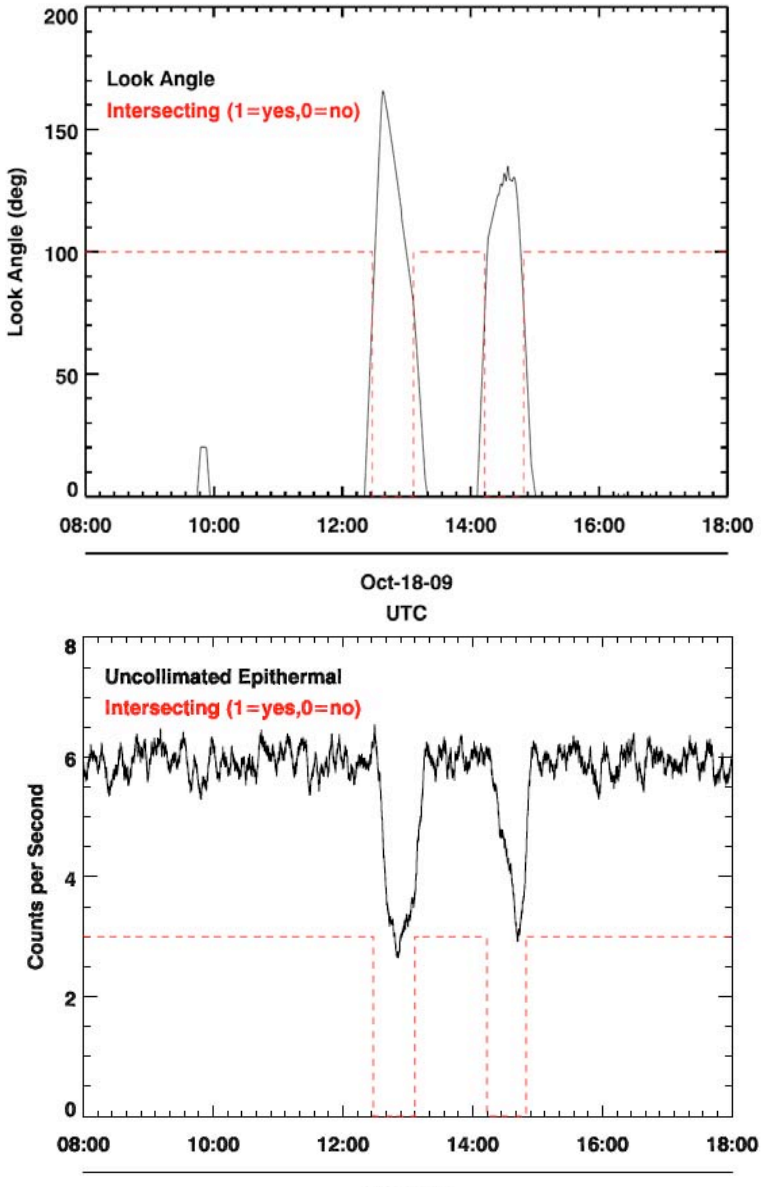
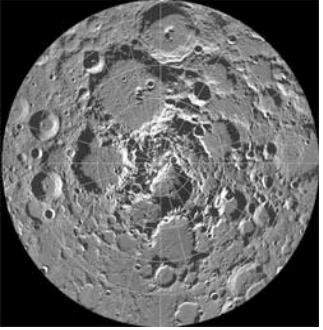
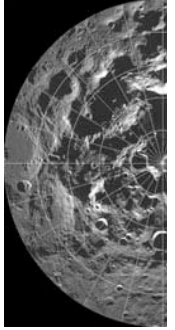


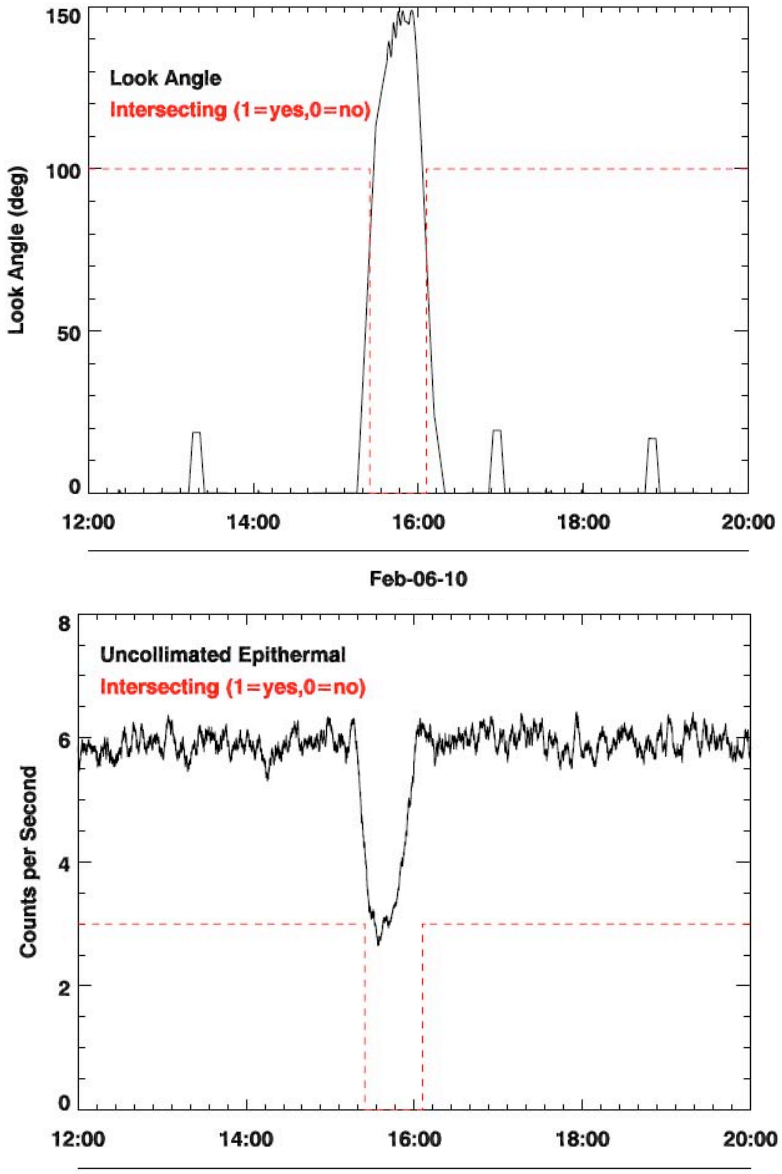


- On Oct. 18, the s/c twice rotated beyond 100°.
- Uncollimated epithermal sensor shows strong counting rate changes duri rotation.
  - Spacecraft/collimator mate is blocking the Moon and sensors do not measure dire lunar neutrons.
  - Quantitative understanding requires spacecraft mass model.

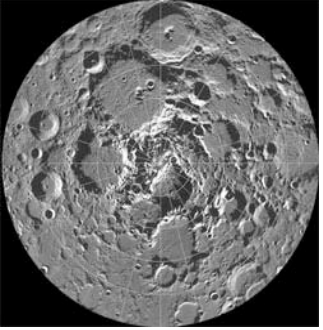


Spacecraft Rotation

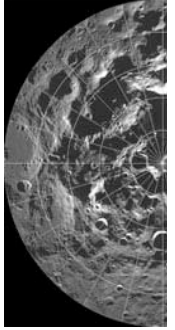


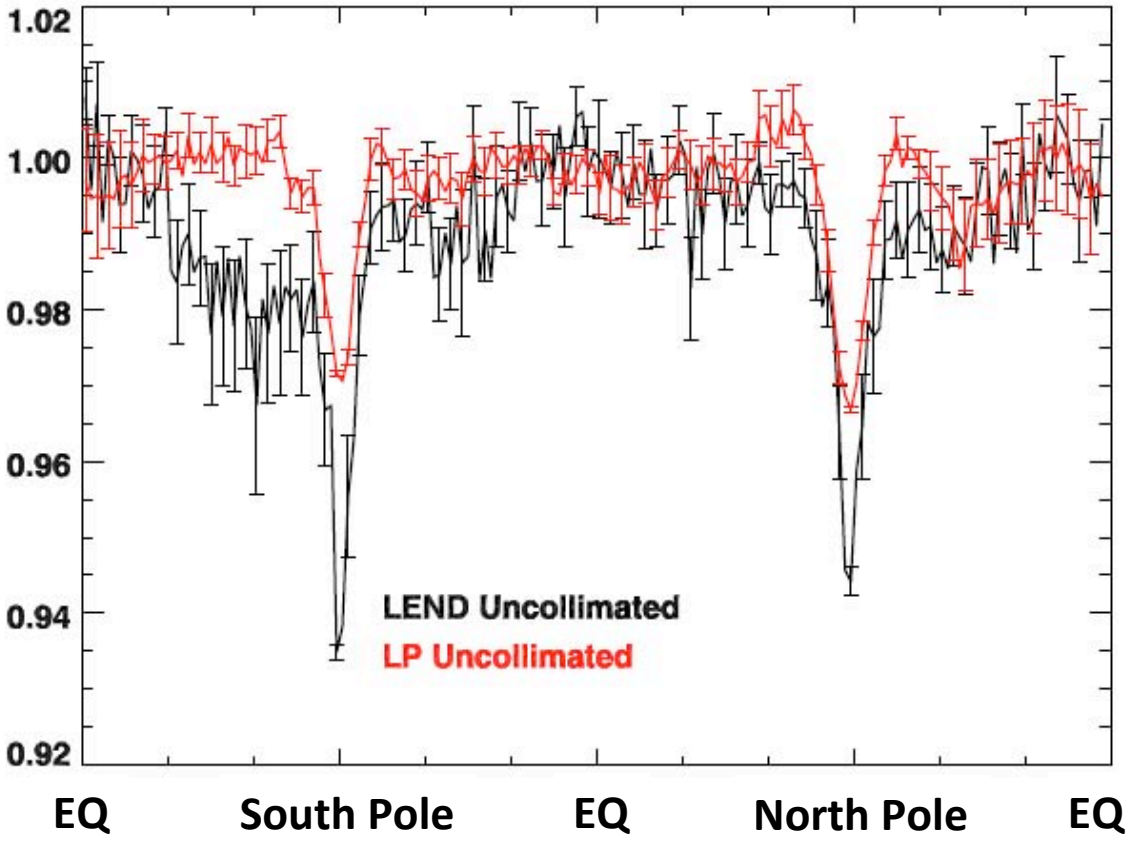


- On Feb. 6, the s/c once rotated beyond 100°.
- Uncollimated epithermal sensor shows strong counting rate changes duri rotation.
  - Spacecraft/collimator mate is blocking the Moon and sensors do not measure dire lunar neutrons.
  - Quantitative understanding requires spacecraft mass model.

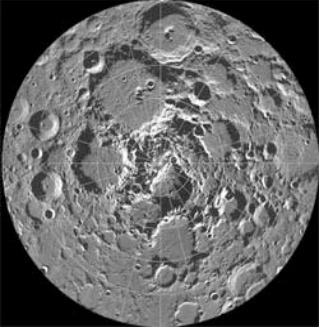


Uncollimated Polar Measurements

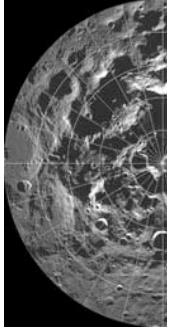


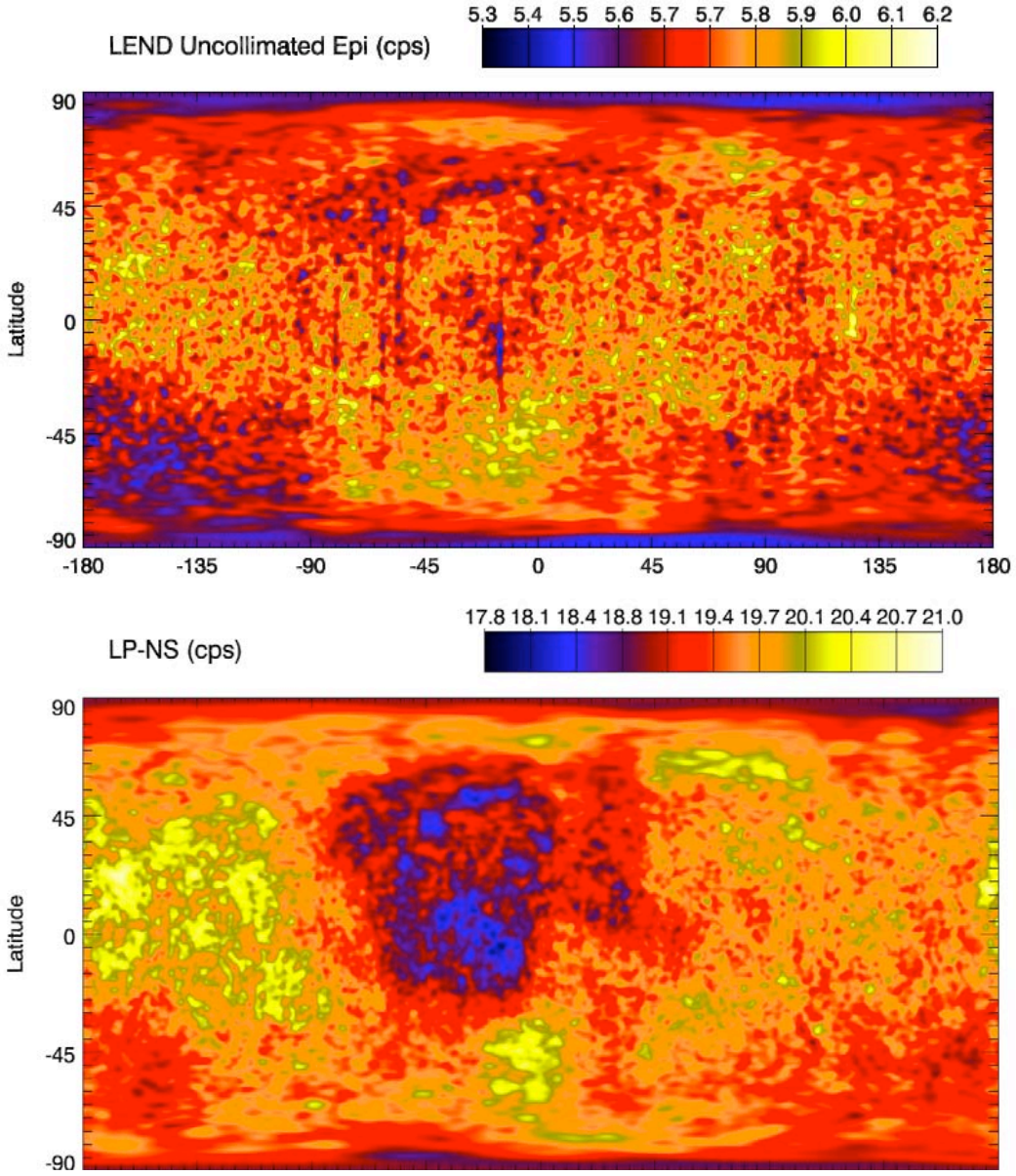


- Epithermal neutron show decrease at each pole.
- Uncollimated epithermal senso qualitatively similar to Lunar Prospector.



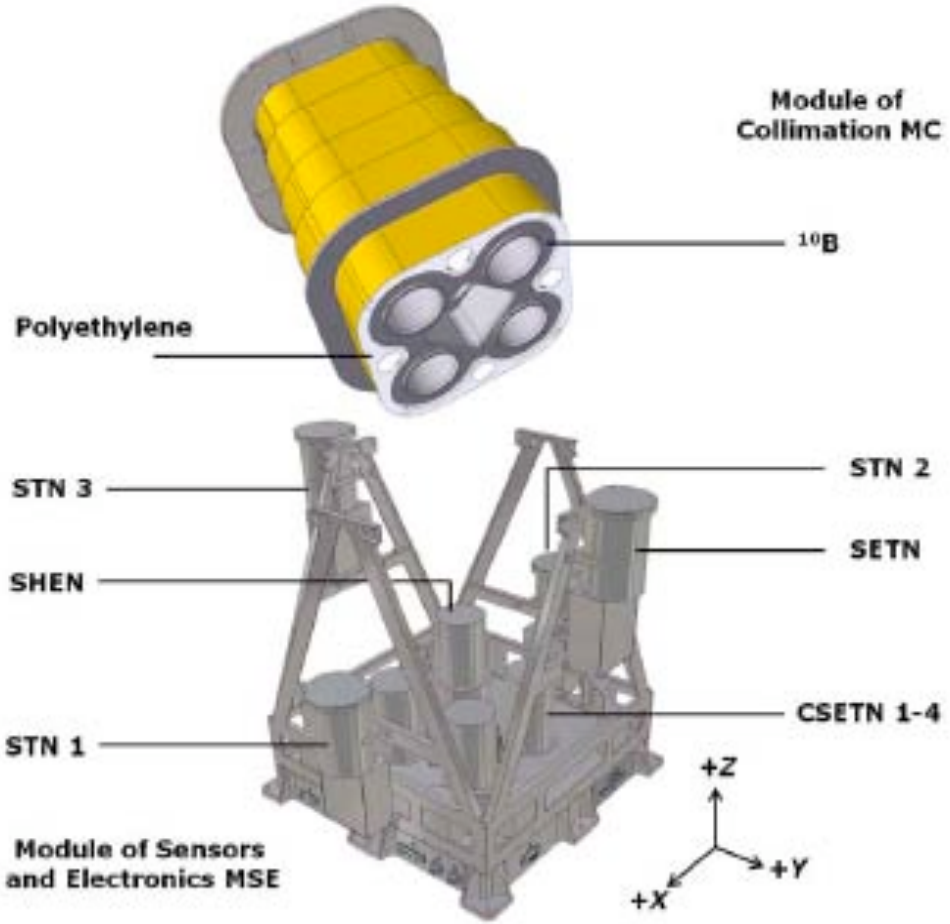
Global Maps





- Global map of uncollimated epithermal sensor (*top*).
- Vertical stripes due to imperfect time-series corrections.
- Qualitatively simila to Lunar Prospecto

LEND Sensor Overview



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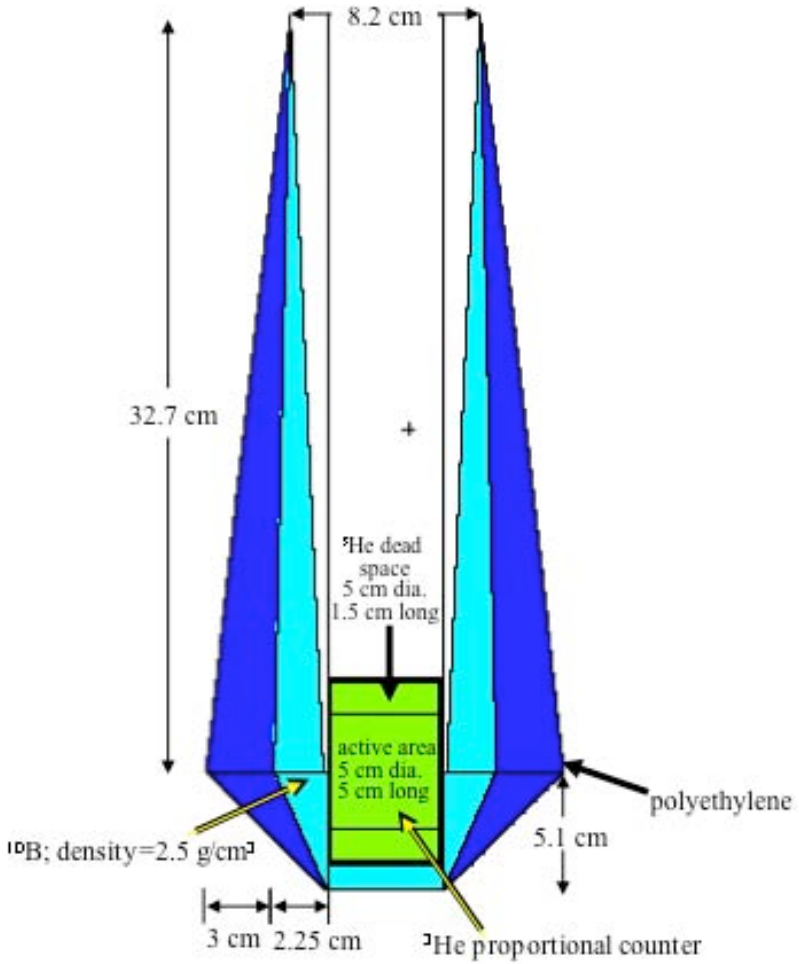
LEND Sensor Overview

Collimated Sensor



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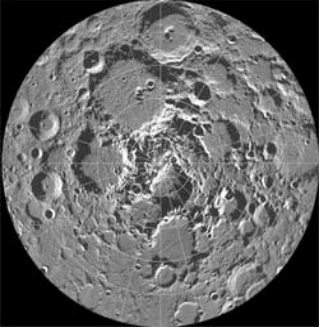
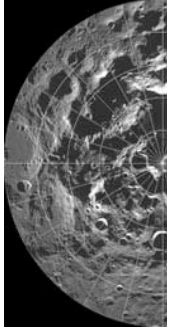
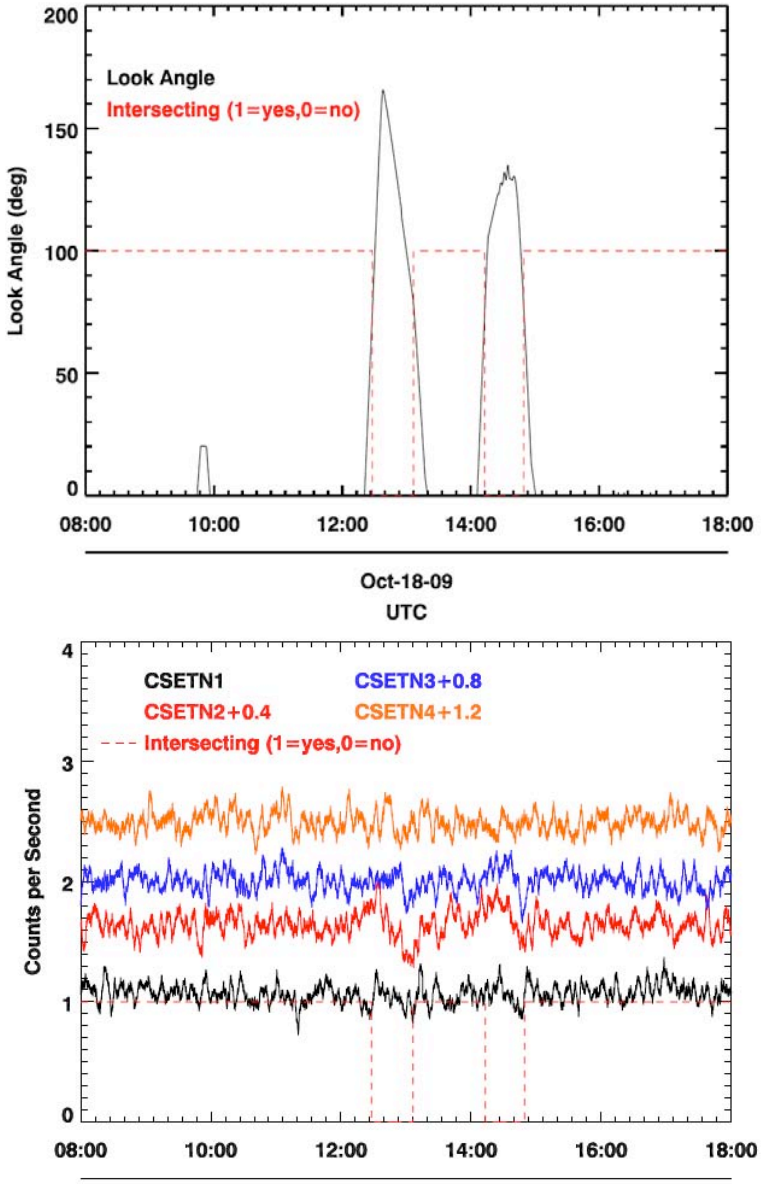
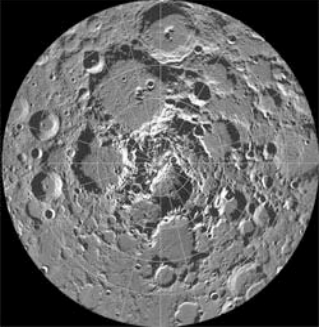


Spacecraft Rotation





- Data from Oct. 18.
- Collimated sensors show little change in counting rate during rotation (<2%).
- Small rotation effect not originally expected.
  - Ongoing discussions with LEND team to fully understand.



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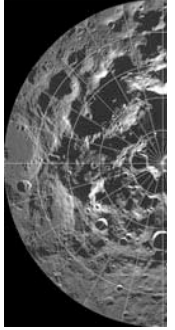

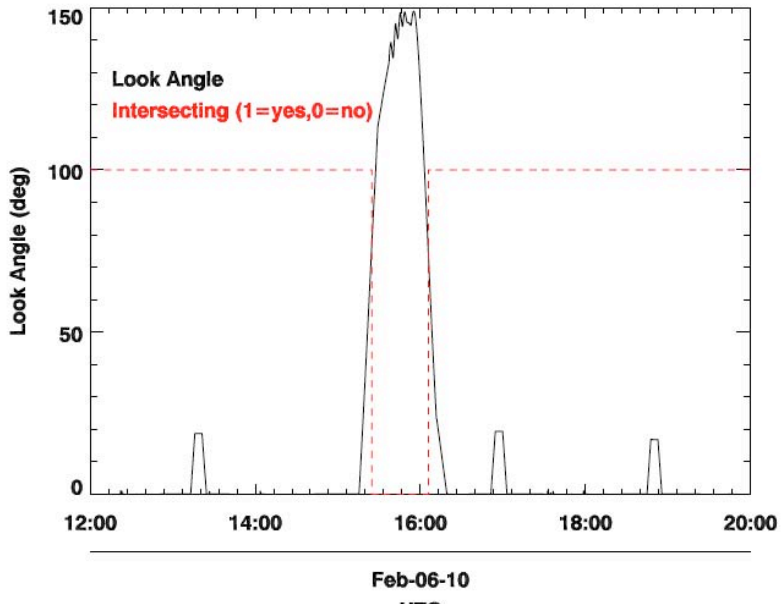

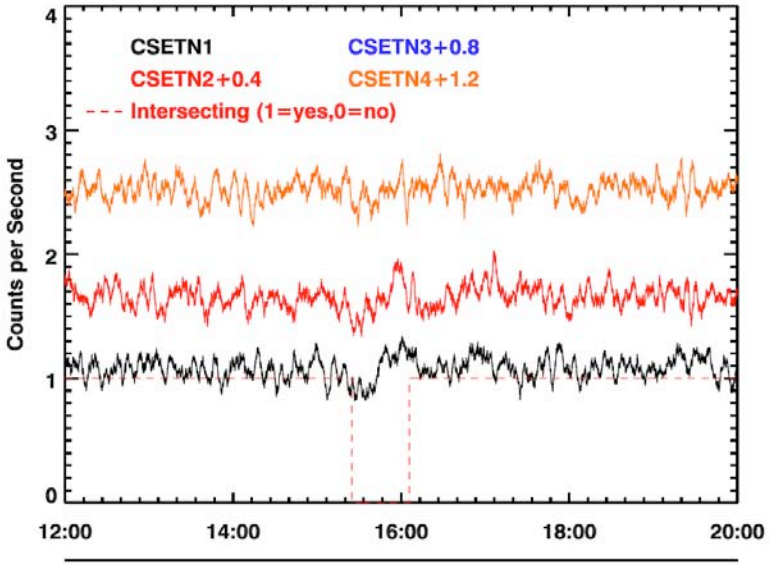

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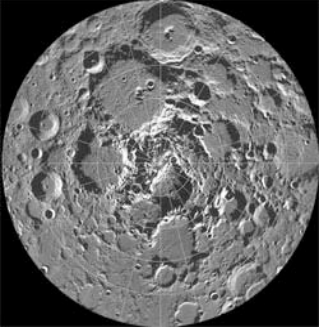
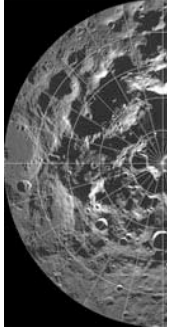
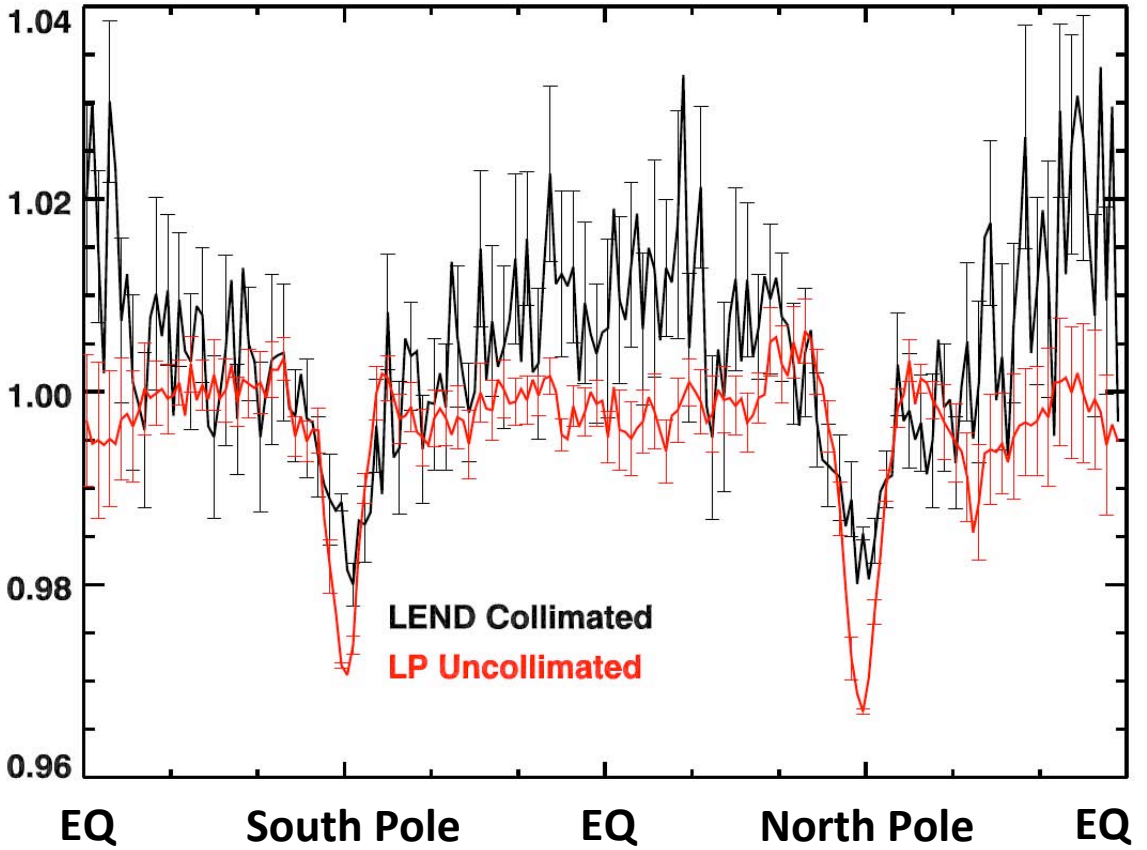
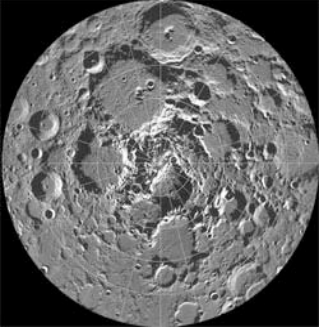


Collimated Polar Measurements

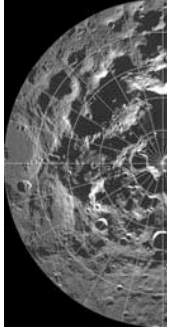


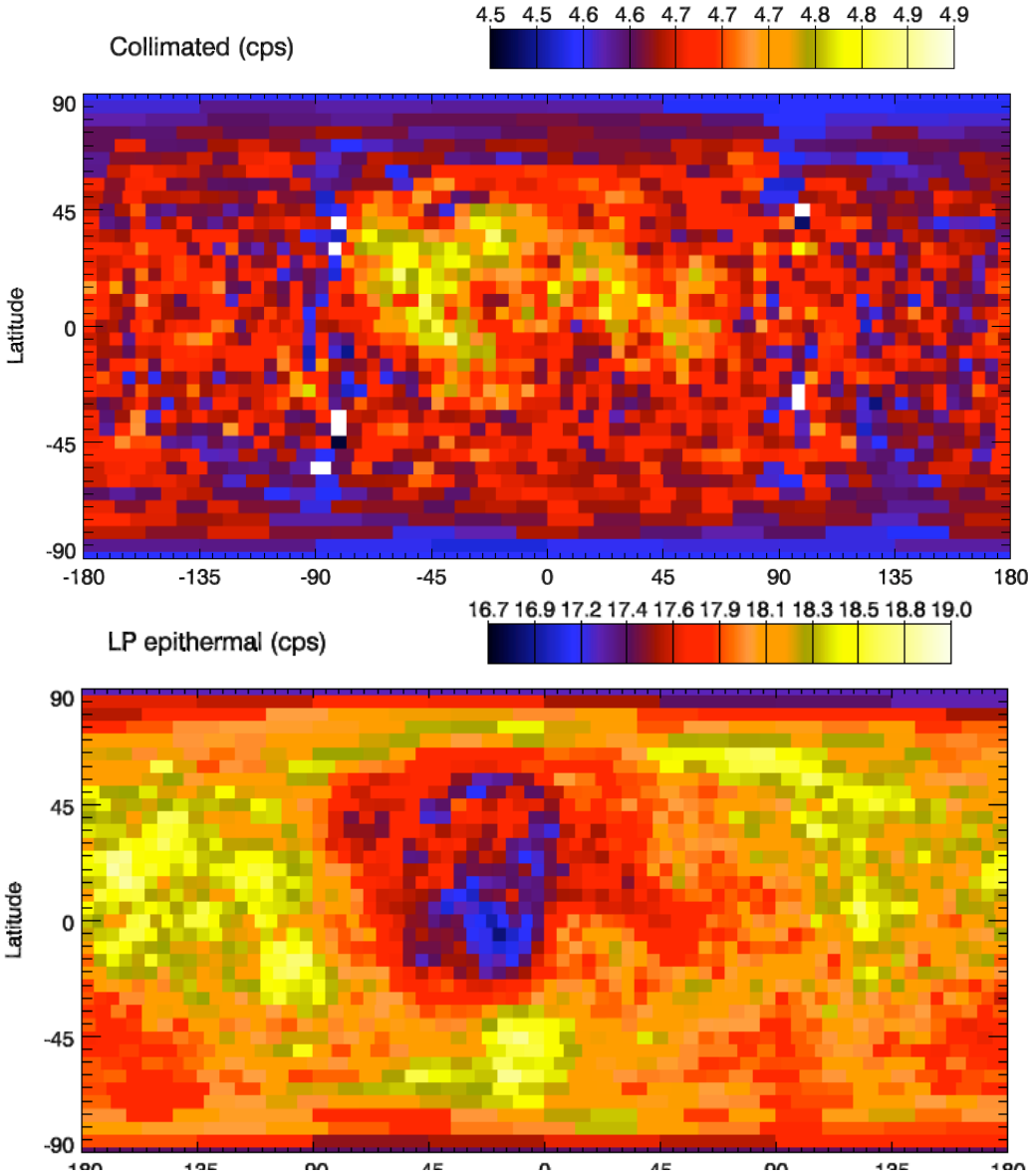


- Shows similarity to Lunar Prospector epithermal neutrons, yet with poorer statistics.

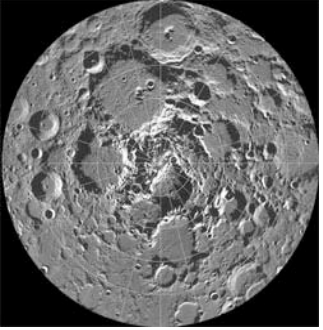


Global Maps





- Global map of all collimated detectors (*top*).
  - 5x5 deg equal-area pixe for better statistics.
- Comparison with Luna Prospector (LP) epithermals.
  - Collimated sensors sho nearside increase.
  - Uncollimated LP shows nearside decrease.
- Collimated map simila to LP fast neutrons.



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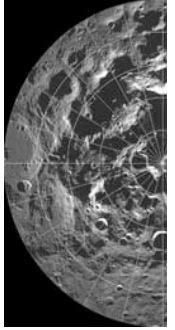

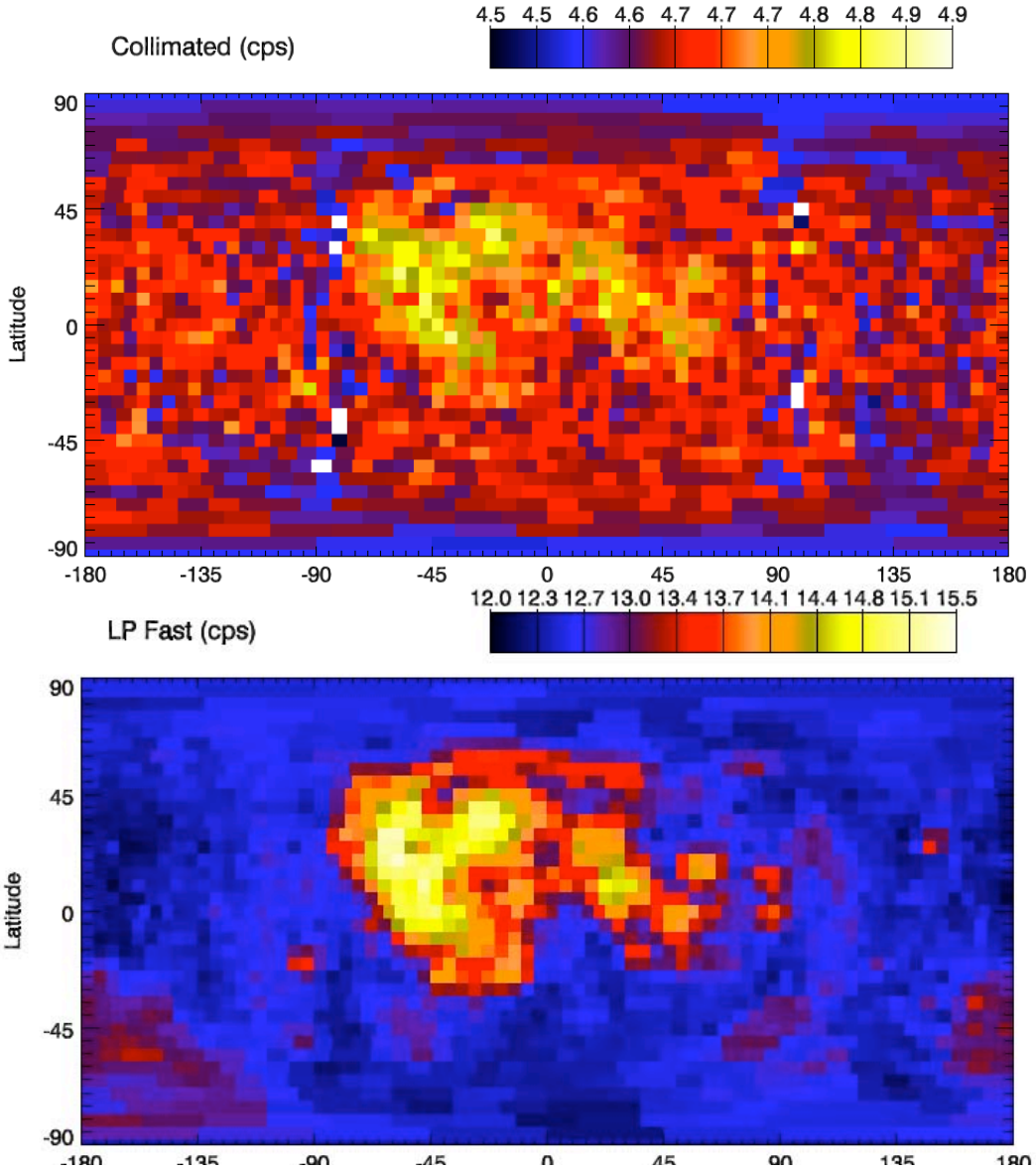

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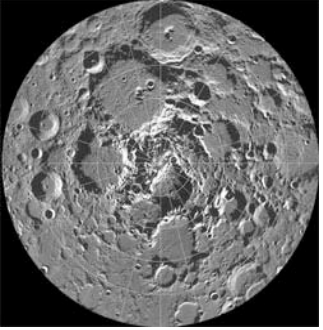
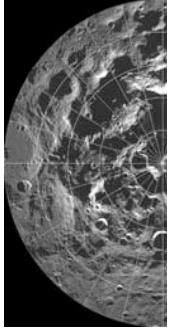


Conclusions



- Uncollimated sensor gives results consistent with Lunar Prospector epithermal neutrons.
  - Better uncollimated results (maps) are expected with more statistics and comprehensive data processing.
- Spacecraft rotation analysis shows effect with uncollimated sensor but not with collimated data.
  - Off-nadir slews provide key flight data to evaluate sensor angular response.
- Collimated sensors show both epithermal and fast neutron components.